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Earth Observing System (EOS)
Advanced Microwave Sounding Unit-A (AMSU-A)
Special Test Equipment
Software Requirements

Contract No: NAS 5-32314
CDRL: 306-2a

Submitted to:

National Aeronautics and Space Administration
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Greenbelt, Maryland 20771

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TABLE OF CONTENTS

TABLE OF CONTENTS (CONT.)

TABLE OF CONTENTS (CONT.)

FIGURES

TABLES

Section 1

INTRODUCTION

1.1 Introduction

This is the Software Requirements Specification for the Earth Observing System (EOS)/Advanced Microwave Sounding Unit-A (AMSU-A) Special Test Equipment (STE) used to test the instrument. This document is submitted in response to Contract NAS 5-32314, CDRL 306-2a. (CDRL 306-2b is the companion "Firmware Requirements Document.")

1.2 Scope

This document describes the software requirements for the EOS/AMSU-A STE.

1.3 Purpose and Objectives

The purpose of this document is to specify the functional, performance, and interface requirements for the software. It also specifies the major characteristics, implementation constraints, and design goals for the software.

1.4 Document Status and Schedule

This is a revised version to be submitted prior to the Software Critical Design Review (CDR) and a final version will be submitted prior to the Software Acceptance Review.

1.5 Documentation Organization

The EOS/AMSU-A Software Documentation Tree is shown in Table I.

Table I EOS/AMSU-A Software Documentation Tree

Document	CDRL Number
Software Management Plan	CDRL 008
Acquisition Activities Plan	CDRL 508
Software Standards and Procedures	CDRL 402
Assurance Plan	CDRL 309
Configuration Management Plan	CDRL 005
Software Product Specifications	CDRL 306
Software Product Specifications	CDRL 306
Software Concept Document	
Software Requirements	
Software Detailed Design Document	
Software Architectural Design Document	
Firmware Support Manual	
Software Version Description	
Operations Procedure Manual	
User's Guide	
Software Maintenance Manual	
Firmware Product Specification	CDRL 306
Firmware Concept Document	
Firmware Requirements	
Firmware Interface Requirements Document	
Firmware Architectural Design Document	
Firmware Version Description	
Software Test Plan	CDRL 033
Software Test Procedures	CDRL 415
Software Test Reports	CDRL 217
Firmware Test Procedures	CDRL 415
Firmware Test Reports	CDRL 217

Section 2

RELATED DOCUMENTATION

2.1 Parent Documents

None

2.2 Applicable Documents

The following documents are referenced or applicable to this report. Unless otherwise specified, the latest issue is in effect.

National Aeronautics and Space Administration

GSFC 422-10-04	Earth Observing System (EOS) Instrument Project Software Acquisition Management Plan
NASA-DID-P200	Requirements Data Item Description
NASA-DID-999	Template Data Item Description
422-11-12-01	General Interface Requirements Document (GIRD)
MIL-STD-1553	Aircraft Internal Time Division Command/Response Multiplex Data Bus

Aerojet

Report 10377	EOS/AMSU-A Engineering Telemetry Description

2.3 Information Documents

None

Section 3

REQUIREMENTS APPROACH AND TRADEOFFS

The EOS/AMSU-A STE software requirements were created using a logical, systematic approach in determining the requirements. Since an STE exists for the AMSU-A instrument, much of the systematic approach focused on the changes from the AMSU-A STE. The systematic approach is:

a. Determine sensor data input availability and format.

b. Identify sensor data acquisition and timing.

c. Determine the performance status and environmental parameter requirements.

d. Identify sensor data entities required to satisfy measurement activities in Step c.

e. Identify measurement parameters, statistics, and algorithms required.

f. Identify expected values using measurement parameters.

g. Determine hardware constraints and data acquisition sensitivities and errors.

h. Identify uncertainties associated with application of measurement parameters.

i. Based on Steps e through h, determine overall expected performance and environmental parameter values.

j. Determine the acceptance range of values, incorporating error tolerances (steps g and h), and establish threshold criteria based on these ranges.

k. Determine sensor status/data display requirements; determine performance and environmental parameter display requirements.

No further trade studies were performed.

Section 4

EXTERNAL INTERFACE REQUIREMENTS

The external interfaces to the EOS/AMSU-A STE software (see Figure 1) are indicated below.

4.1 Disk Drive - DEC Model RD53 and DEC Model RD54 Units

The Digital Equipment Corporation (DEC) disk drives shall: 1) record all data acquired during STE instrument monitoring and calibration testing processes; 2) retrieve all data from tape for playback during calibration testing. The data shall include:

a. Sensor data:

1. Engineering Data

2. Low Rate Science Data

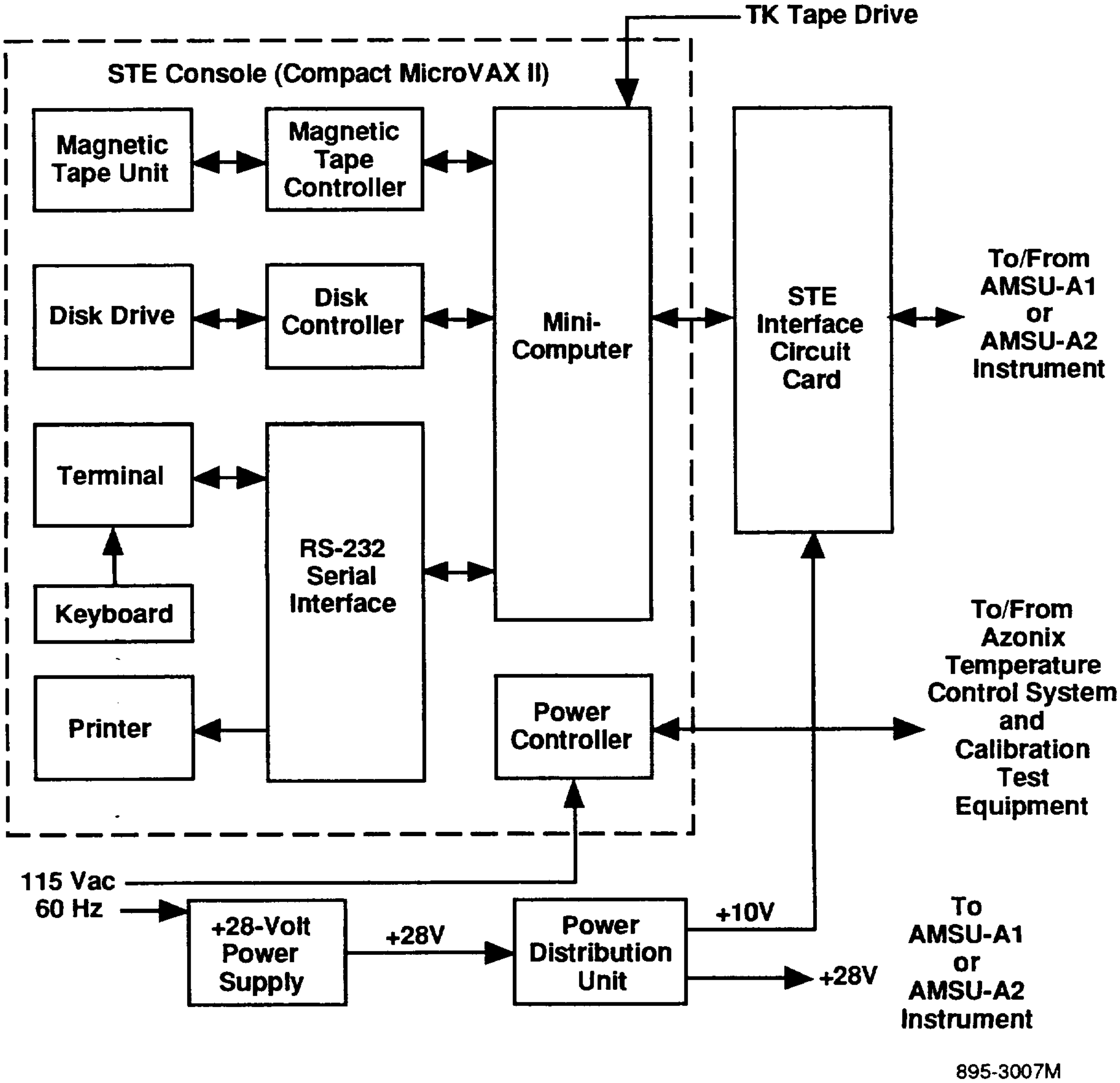

Figure 1 Special Test Equipment Block Diagram

b. Calibration Test Equipment (CTE) input data:

   1. Platinum Resistance Thermometer (PRT) data

   2. Thermocouple data.

The STE to Disk Drive interface shall be a standard disk controller coupling interface.

4.2 Magnetic Tape Unit (MTU) - DEC Model TS05 Unit

The MTU shall be a source for archiving recorded data. The MTU shall be used to:

a. Archive requested disk files to tape

b. Retrieve requested disk files from tape for playback through STE algorithms.

The STE tape unit interface shall be a standard magnetic tape controller coupling interface.

4.3 TK50 Tape Unit

The TK50 tape unit 1 shall be an alternate source for archiving recorded data. The TK50 shall be used to:

a. Archive requested disk files to tape

b. Retrieve requested disk files from tape for playback through STE algorithms.

The STE to TK50 Interface shall be a standard tape drive coupling interface.

4.4 Video Terminal and Keyboard

The keyboard shall allow input from the operator to control the STE software. The video terminal shall display information from the STE software and test equipment. The video terminal shall display current and CTE data. The keyboard shall allow the operator to initiate commands to change modes.

The interface between the STE and video terminal as well as the STE and keyboard shall both be a RS-232 serial interface.

4.5 Printer

The line printer shall be a DEC Model LA210-A2 line printer. The printer shall print raw data and calibration results when requested by the STE software. The STE software shall output to the printer:

a. 8-second scan data frames

b. Current sensor data

   1. Low rate science data

   2. Engineering data

c. Current CTE data

   1. Thermocouple temperatures

2. PRT temperatures

d. Calibration test results (i.e. calibration correction factor, gain drift, noise equivalent delta temperature (NEΔT), calibration accuracy, load stability, instrument temperature stability, warm load to variable load delta, calibration repeatability, linearity)

e. Error messages.

The interface between the STE and printer shall be a RS-232 serial interface.

4.6 EOS/AMSU-A Instrument

The instrument, or sensor, provides radiometric and status data to the STE. The STE software shall:

a. Acquire instrument data at a rate to insure all available data is retrieved and shall include:

   1. Low rate science data

   2. Engineering data

b. Output commands to the instrument to:

   1. Turn power on/off to instrument components

   2. Adjust antenna position

   3. Select between hardware redundant elements.

The STE to EOS/AMSU-A interfaces shall be MIL-STD-1553 interface. This new bus interface replaces the proprietary bus that was used in AMSU-A. Even though there are redundant cables, only one is used at a time.

4.7 Temperature Measurement and Control System

The Azonix System 1000 Computational Control System, Temperature Measurement and Control System (TMCS), shall allow instrument calibration based on specified target temperatures. The TMCS shall accept calibration data input and target temperature output. The calibration data includes;

a. Calibration thermal test data (i.e. PRTs, Thermocouple) which shall be output from the CTE to the Azonix (serial input) for STE software acquisition.

b. Target temperature output. The STE software shall interact with the Thermal Control System to allow operators to modify CTE target temperatures.

The STE to Azonix Interface shall be an RS-232 serial interface.

4.8 Unpowered PRTs

The unpowered PRTs shall be available when the power is turned off. The unpowered PRTs shall be monitored by the STE software before turning the instrument power on.

The STE to unpowered PRTs shall be a RS-232 serial interface.

Section 5

REQUIREMENTS SPECIFICATION

5.1 Process and Data Requirements

The following paragraphs describes input, process, and output requirements for the EOS/AMSU-A STE software, organized by function.

5.1.1 Input Data and Sources. Tables II through VII describe the data: definition, validity check requirements, parameterization requirements, and format or implementation restrictions. The sections below describe the data relationships and structure. There are no data protection requirements.

5.1.1.1 Sensor Data

5.1.1.1.1 Unit Data Structure. Data is output to the firmware for transfer across the MIL-STD-1553 interface. The headers contain the packet header PR1 and SEC (start of scan data) and the Scan Identification (Unit ID and serial number that precedes the scan data). The headers are described in Figures 2 and 3. The data are comprised of 3 data types (Low Rate Science Data, Engineering Data, and Unpowered PRTs). The data shall be accessed by the STE at approximately 8 second scan intervals. The operator shall be able to display either full scan or select scan positions: 1) Full Scan (see Figure 4 for Unit A1 and Figure 5 for A2); 2) Warm Calibration (see Figures 6 and 7); 3) Cold Calibration (see Figures 8 and 9); 4) Nadir beam position (see Figures 10 and 11).

5.1.1.1.1.1 Low Rate Science Data. The low rate science data consists of warm load temperature, reflector position, and radiometric data (see Figures 4 and 12 for Unit A1 or Figures 5 and 13 for A2). Data acquisition shall begin after the operator enables input through the STE software. The transfer will be via MIL-STD-1553 transfer across the instrument Low Rate Science interface. Additional Data information is found in Table II.

For description of scanner mode set to full scan mode, see Table III in the Digital Telemetry Data rows.

5.1.1.1.1.2 Engineering Data. Engineering, or Engineering Telemetry, data received from the instrument shall include digital telemetry data, temperature data, and current/voltage. Report 10377 further describes the Engineering Telemetry data. Data acquisition shall begin after the operator enables input throughout the STE software. The transfer will be via MIL-STD-1553 transfer across the instrument Engineering Data interface.

5.1.1.1.1.2.1 Digital Telemetry Data Group. The Digital Telemetry data group consists of instrument power, positioning status, and feedback from operator commands. See Figures 4, 14, and 15 for Unit A1 or Figures 5, 16, and 17 for A2. Additional Data information is found in Table III.

5.1.1.1.1.2.2 Temperature Data Group. See Figures 4 and 12 for Unit A1 or 6 and 13 for A2. Additional Data information is found in Table IV.

5.1.1.1.1.2.3 Current/Voltage Group. The current/voltage group consists of primary bus currents and secondary voltages applied at critical component circuitry, formatted as analog counts. For additional information, see Figures 2 and 3.

5.1.1.1.1.3 Unpowered PRTs. The unpowered PRTs consists of temperatures applied at critical component circuitry, formatted as analog counts. This data is available over a RS-232 interface when the instrument is unpowered. See Figure 18. Additional Data information is found in Table V.

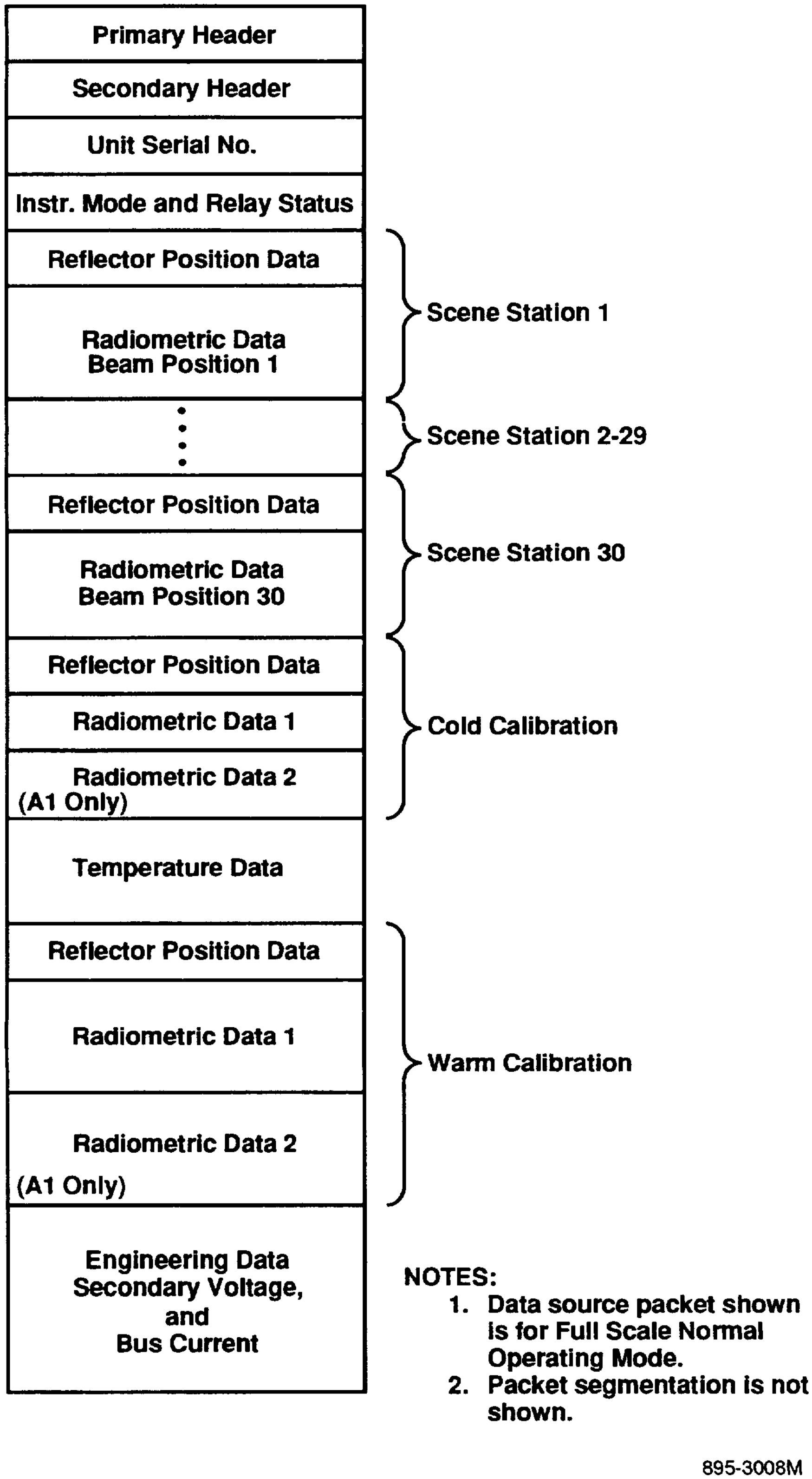

Figure 2 Science Data Source Packet

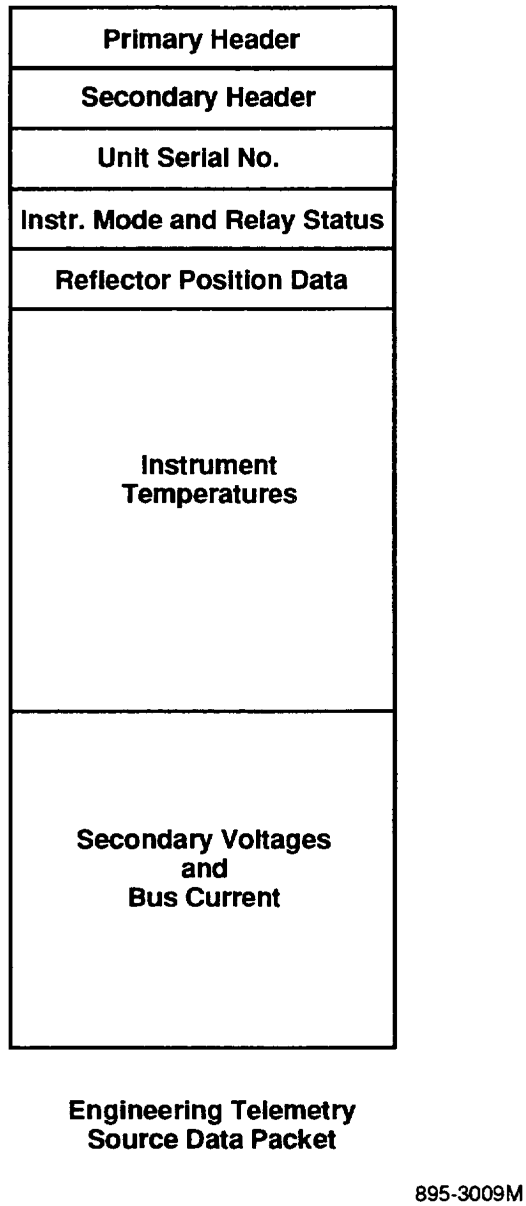

Figure 3 AMSU-A Engineering Telemetry Source Data Packet

Parameter	
Reflector 1, Position 1, MSP, First reading	Word 11
Reflector 1, Position 1, LSP, First reading	Word 11
Reflector 2, Position 1, MSP, First reading	Word 12
Reflector 2, Position 1, LSP, First reading	Word 12
Reflector 1, Position 1, MSP, Second reading	Word 13
Reflector 1, Position 1, LSP, Second reading	Word 13
Reflector 2, Position 1, MSP, Second reading	Word 14
Reflector 2, Position 1, LSP, Second reading	Word 14
Scene Position 1, Channel 3, MSP	Word 15
Scene Position 1, Channel 3, LSP	Word 15
Scene Position 1, Channel 4, MSP	Word 16
Scene Position 1, Channel 4, LSP	Word 16

Scene Position 1, Channel 15, MSP	Word 27
Scene Position 1, Channel 15, LSP	Word 27
Reflector 1, Position 2, MSP, First reading	Word 28
Reflector 1, Position 2, LSP, First reading	Word 28
Reflector 2, Position 2, MSP, First reading	Word 29
Reflector 2, Position 2, LSP, First reading	Word 29
Reflector 1, Position 2, MSP, Second reading	Word 30
Reflector 1, Position 2, LSP, Second reading	Word 30
Reflector 2, Position 2, MSP, Second reading	Word 31
Reflector 2, Position 2, LSP, Second reading	Word 31
Scene Position 2, Channel 3, MSP	Word 32
Scene Position 2, Channel 3, LSP	Word 32

Scene Position 2, Channel 15, MSP	Word 44
Scene Position 2, Channel 15, LSP	Word 44
Reflector 1, Position 3, MSP, First reading	Word 45
Reflector 1, Position 3, LSP, First reading	Word 45
Reflector 2, Position 3, MSP, First reading	Word 46
Reflector 2, Position 3, LSP, First reading	Word 46
Reflector 1, Position 3, MSP, Second reading	Word 47
Reflector 1, Position 3, LSP, Second reading	Word 47
Reflector 2, Position 3, MSP, Second reading	Word 48
Reflector 2, Position 3, LSP, Second reading	Word 48

Figure 4 Full Scan Mode, Unit A1 (Sheet 1 of 3)

Parameter	
Scene Position 3, Channel 3, MSP	Word 49
Scene Position 3, Channel 3, LSP	Word 49

Scene Position 30, Channel 15, MSP	Word 520
Scene Position 30, Channel 15, LSP	Word 520
Reflector 1, Cold Cal. Position, MSP, First reading	Word 521
Reflector 1, Cold Cal. Position, LSP, First reading	Word 521
Reflector 2, Cold Cal. Position, MSP, First reading	Word 522
Reflector 2, Cold Cal. Position, LSP, First reading	Word 522
Reflector 1, Cold Cal. Position, MSP, Second reading	Word 523
Reflector 1, Cold Cal. Position, LSP, Second reading	Word 523
Reflector 2, Cold Cal. Position, MSP, Second reading	Word 524
Reflector 1, Cold Cal. Position, LSP, Second reading	Word 524
Cold Calibration 1, Channel 3 MSP	Word 525
Cold Calibration 1, Channel 3, LSP	Word 525
Cold Calibration 1, Channel 4, MSP	Word 526
Cold Calibration 1, Channel 4, LSP	Word 526

Cold Calibration 1, Channel 15 MSP	Word 537
Cold Calibration 1, Channel 15, LSP	Word 537
Cold Calibration 2, Channel 3, MSP	Word 538
Cold Calibration 2, Channel 3, LSP	Word 538
Cold Calibration 2, Channel 4, MSP	Word 539
Cold Calibration 2, Channel 4, LSP	Word 539

Cold Calibration 2, Channel 15 MSP	Word 550
Cold Calibration 2, Channel 15, LSP	Word 550
Temp Sensor 1, MSP	Word 551
Temp Sensor 1, LSP	Word 551
Temp Sensor 2, MSP	Word 552
Temp Sensor 2, LSP	Word 552

Temp Sensor 45, MSP	Word 595
Temp Sensor 45, LSP	Word 595

See Figure 12

Figure 4 Full Scan Mode, Unit A1 (Sheet 2 of 3)

Parameter	
Temp Sensor Reference Voltage, MSP	Word 596
Temp Sensor Reference Voltage, LSP	Word 596
Reflector 1 Warm Cal. Position, MSP, First reading	Word 597
Reflector 1 Warm Cal. Position, LSP, First reading	Word 597
Reflector 2 Warm Cal. Position, MSP, First reading	Word 598
Reflector 2 Warm Cal. Position, LSP, First reading	Word 598
Reflector 1 Warm Cal. Position, MSP, Second reading	Word 599
Reflector 1 Warm Cal. Position, LSP, Second reading	Word 599
Reflector 2 Warm Cal. Position, MSP, Second reading	Word 600
Reflector 2 Warm Cal. Position, LSP, Second reading	Word 600
Warm Calibration 1, Channel 3, MSP	Word 601
Warm Calibration 1, Channel 3, LSP	Word 601
Warm Calibration 1, Channel 15, MSP	Word 613
Warm Calibration 1, Channel 15, LSP	Word 613
Warm Calibration 2, Channel 3, MSP	Word 617
Warm Calibration 2, Channel 3, LSP	Word 617
Warm Calibration 2, Channel 15, MSP	Word 626
Warm Calibration 2, Channel 15, LSP	Word 626

NOTES:

1. In the above table, the MSP is the most significant portion of a particular measurement while the LSP is the least significant portion of a particular measurement.
2. In the above table, the first set of readings for a particular reflector position are made prior to the integration interval, while the second set of readings are made approximately half way through the integration period.
3. Digital A data as read by the spacecraft shall contain an undetermined number of fill words. These fill words shall be 0001H and will be intermingled with valid data. The Digital A data as sent by the instrument shall be such that no valid data of 0001H shall be included.
4. Format of Position data is: DDDDDDDDDDDDDDE0, where
   D = Data
   E = Error bit, 0 = not in spec, 1 = in spec
   0 = Zero
5. Format of Radiometer data is: DDDDDDDDDDDDDDD0, where
   D = Data and 0 = Zero
6. The temperature sensor reference voltage is utilized for temperature sensors 36 through 45 only.

Figure 4 Full Scan Mode, Unit A1 (Sheet 3 of 3)

Parameter	
Reflector, Position 1, MSP, First reading	Word 11
Reflector, Position 1, LSP, First reading	Word 11
Reflector 2, Position 1, MSP, Second reading	Word 12
Reflector 2, Position 1, LSP, Second reading	Word 12
Scene Position 1, Channel 1, MSP	Word 13
Scene Position 1, Channel 1, LSP	Word 13
Scene Position 1, Channel 2, MSP	Word 14
Scene Position 1, Channel 2, LSP	Word 14
Reflector, Position 2, MSP, First reading	Word 15
Reflector, Position 2, LSP, First reading	Word 15
Reflector, Position 2, MSP, Second reading	Word 16
Reflector, Position 2, LSP, Second reading	Word 16
Scene Position 2, Channel 1, MSP	Word 17
Scene Position 2, Channel 1, LSP	Word 17
Scene Position 2, Channel 2, MSP	Word 18
Scene Position 2, Channel 2, MSP	Word 18
Reflector, Position 3, MSP, First reading	Word 19
Reflector, Position 3, LSP, First reading	Word 19
Reflector, Position 3, MSP, Second reading	Word 20
Reflector, Position 3, LSP, Second reading	Word 20
Scene Position 3, Channel 1, MSP	Word 21
Scene Position 3, Channel 1, LSP	Word 21

Scene Position 30, Channel 2, MSP	Word 130
Scene Position 30, Channel 2, LSP	Word 130
Reflector, Cold Cal. Position, MSP, First reading	Word 131
Reflector, Cold Cal. Position, LSP, First reading	Word 131
Reflector, Cold Cal. Position, MSP, Second reading	Word 132
Reflector, Cold Cal. Position, LSP, Second reading	Word 132
Cold Calibration 1, Channel 1, MSP	Word 133
Cold Calibration 1, Channel 1, LSP	Word 133
Cold Calibration 1, Channel 2, MSP	Word 134
Cold Calibration 1, Channel 2, MSP	Word 134
Cold Calibration 2, Channel 1, MSP	Word 135
Cold Calibration 2, Channel 1, LSP	Word 135
Cold Calibration 2, Channel 2, MSP	Word 136
Cold Calibration 2, Channel 2, MSP	Word 136

Figure 5 Full Scan Mode, Unit A2 (Sheet 1 of 2)

Parameter	
Temp Sensor 1, MSP	Word 137
Temp Sensor 1, LSP	Word 137
Temp Sensor 2, MSP	Word 138
Temp Sensor 2, LSP	Word 138

See Figure 13

Temp Sensor 1, MSP	Word 155
Temp Sensor 1, LSP	Word 155
Temp Sensor Reference Voltage, MSP	Word 156
Temp Sensor Reference Voltage, LSP	Word 156
Reflector, Warm Cal. Position, MSP, First reading	Word 157
Reflector, Warm Cal. Position, LSP, First reading	Word 157
Reflector, Warm Cal. Position, MSP, Second reading	Word 158
Reflector, Warm Cal. Position, LSP, Second reading	Word 158
Warm Calibration 1, Channel 1, MSP	Word 159
Warm Calibration 1, Channel 1, LSP	Word 159
Warm Calibration 1, Channel 2, MSP	Word 160
Warm Calibration 1, Channel 2, LSP	Word 160
Warm Calibration 2, Channel 1, MSP	Word 161
Warm Calibration 2, Channel 1, LSP	Word 161
Warm Calibration 2, Channel 2, MSP	Word 162
Warm Calibration 2, Channel 2, LSP	Word 162

NOTES:

1. In the above table, the MSP is the most significant portion of a particular measurement while the LSP is the least significant portion of a particular measurement.
2. In the above table, the first set of readings for a particular reflector position are made prior to the integration interval, while the second set of readings are made approximately half way through the integration period.
3. Digital A data as read by the spacecraft shall contain an undetermined number of fill words. These fill words shall be 0001H and will be intermingled with valid data. The Digital A data as sent by the instrument shall be such that no valid data of 0001H shall be included.
4. Format of Position data is: DDDDDDDDDDDDDDE0, where
   D = Data
   E = Error bit, 0 = not in spec, 1 = in spec
   0 = Zero
5. Format of Radiometer data is: DDDDDDDDDDDDDDD0, where
   D = Data and 0 = Zero
6. The temperature sensor reference voltage is utilized for temperature sensors 13 through 19 only.

Figure 5 Full Scan Mode, Unit A2 (Sheet 2 of 2)

Parameter	
Reflector 1, Warm Cal. Position, MSP, First Reading	Word 11
Reflector 1, Warm Cal. Position, LSP, First Reading	Word 11
Reflector 2, Warm Cal. Position, MSP, First Reading	Word 12
Reflector 2, Warm Cal. Position, LSP, First Reading	Word 12
Reflector 1, Warm Cal. Position, MSP, Second Reading	Word 13
Reflector 1, Warm Cal. Position, LSP, Second Reading	Word 13
Reflector 2, Warm Cal. Position, MSP, Second Reading	Word 14
Reflector 2, Warm Cal. Position, LSP, Second Reading	Word 14
Warm Cal. Position , Channel 3, MSP	Word 15
Warm Cal. Position , Channel 3, LSP	Word 15
Warm Cal. Position , Channel 4, MSP	Word 16
Warm Cal. Position , Channel 4, LSP	Word 16
Warm Cal. Position , Channel 15, MSP	Word 27
Warm Cal. Position , Channel 15, LSP	Word 27

Words 11 through 27 are repeated 29 times for a total of 30 data sets.

Temp Sensor 1, MSP	Word 521
Temp Sensor 1, LSP	Word 521
Temp Sensor 2, MSP	Word 522
Temp Sensor 2, LSP	Word 522
Temp Sensor 45, MSP	Word 565
Temp Sensor 45, LSP	Word 565
Temp Sensor Reference Voltage, MSP	Word 566
Temp Sensor Reference Voltage, LSP	Word 566

See Figure 12

NOTES:

1. In the above table, the MSP is the most significant portion of a particular measurement while the LSP is the least significant portion of a particular measurement.
2. In the above table, the first set of readings for a particular reflector position are made prior to the integration interval, while the second set of readings are made approximately half way through the integration period.
3. Digital A data as read by the spacecraft shall contain an undetermined number of fill words. These fill words shall be 0001H and will be intermingled with valid data. The Digital A data as sent by the instrument shall be such that no valid data of 0001H shall be included.
4. Format of Position data is: DDDDDDDDDDDDDDE0, where
   D = Data
   E = Error bit, 0 = not in spec, 1 = in spec
   0 = Zero
5. Format of Radiometer data is: DDDDDDDDDDDDDDD0. where
   D = Data and 0 = Zero
6. The temperature sensor reference voltage is utilized for temperature sensors 13 through 19 only.

Figure 6 Warm Cal Mode, Unit A1

Parameter	
Reflector, Warm Cal. Position, MSP, First Reading	Word 11
Reflector, Warm Cal. Position, LSP, First Reading	Word 11
Reflector, Warm Cal. Position, MSP, Second Reading	Word 12
Reflector, Warm Cal. Position, LSP, Second Reading	Word 12
Warm Cal. Position, Channel 1, MSP	Word 13
Warm Cal. Position, Channel 1, MSP	Word 13
Warm Cal. Position, Channel 2, MSP	Word 14
Warm Cal. Position, Channel 2, MSP	Word 14

Words 11 through 14 are repeated 29 times for a total of 30 data sets.

Temp Sensor 1, MSP	Word 131
Temp Sensor 1, LSP	Word 131
Temp Sensor 2, MSP	Word 132
Temp Sensor 2, LSP	Word 132
Temp Sensor 19, MSP	Word 149
Temp Sensor 19, LSP	Word 149
Temp Sensor Reference Voltage, MSP	Word 150
Temp Sensor Reference Voltage, LSP	Word 150

See Figure 13

NOTES:

1. In the above table, the MSP is the most significant portion of a particular measurement while the LSP is the least significant portion of a particular measurement.
2. In the above table, the first set of readings for a particular reflector position are made prior to the integration interval, while the second set of readings are made approximately half way through the integration period.
3. Digital A data as read by the spacecraft shall contain an undetermined number of fill words. These fill words shall be 0001H and will be intermingled with valid data. The Digital A data as sent by the instrument shall be such that no valid data of 0001H shall be included.
4. Format of Position data is: DDDDDDDDDDDDDDE0, where
   D = Data
   E = Error bit, 0 = not in spec, 1 = in spec
   0 = Zero
5. Format of Radiometer data is: DDDDDDDDDDDDDDD0. where
   D = Data and 0 = Zero
6. The temperature sensor reference voltage is utilized for temperature sensors 13 through 19 only.

Figure 7 Warm Cal Mode, Unit A2

Parameter	
Reflector 1, Cold Cal. Position, MSP, First Reading	Word 11
Reflector 1, Cold Cal. Position, LSP, First Reading	Word 11
Reflector 2, Cold Cal. Position, MSP, First Reading	Word 12
Reflector 2, Cold Cal. Position, LSP, First Reading	Word 12
Reflector 1, Cold Cal. Position, MSP, Second Reading	Word 13
Reflector 1, Cold Cal. Position, LSP, Second Reading	Word 13
Reflector 2, Cold Cal. Position, MSP, Second Reading	Word 14
Reflector 2, Cold Cal. Position, LSP, Second Reading	Word 14
Cold Cal. Position, Channel 3, MSP	Word 15
Cold Cal. Position, Channel 3, LSP	Word 15
Cold Cal. Position, Channel 4, MSP	Word 16
Cold Cal. Position, Channel 4, LSP	Word 16

Cold Cal. Position , Channel 15, MSP	Word 27
Cold Cal. Position , Channel 15, LSP	Word 27

Words 11 through 27 are repeated 29 times for a total of 30 data sets.

Temp Sensor 1, MSP	Word 521
Temp Sensor 1, LSP	Word 521
Temp Sensor 2, MSP	Word 522
Temp Sensor 2, LSP	Word 522

Temp Sensor 45, MSP	Word 565
Temp Sensor 45, LSP	Word 565
Temp Sensor Reference Voltage, MSP	Word 566
Temp Sensor Reference Voltage, LSP	Word 566

See Figure 12

NOTES:

1. In the above table, the MSP is the most significant portion of a particular measurement while the LSP is the least significant portion of a particular measurement.
2. In the above table, the first set of readings for a particular reflector position are made prior to the integration interval, while the second set of readings are made approximately half way through the integration period.
3. Digital A data as read by the spacecraft shall contain an undetermined number of fill words. These fill words shall be 0001H and will be intermingled with valid data. The Digital A data as sent by the instrument shall be such that no valid data of 0001H shall be included.
4. Format of Position data is: DDDDDDDDDDDDDDE0, where
   D = Data
   E = Error bit, 0 = not in spec, 1 = in spec
   0 = Zero
5. Format of Radiometer data is: DDDDDDDDDDDDDDD0. where
   D = Data and 0 = Zero
6. The temperature sensor reference voltage is utilized for temperature sensors 13 through 19 only.

Figure 8 Cold Cal Mode, Unit A1

Parameter	
Reflector, Cold Cal. Position, MSP, First Reading	Word 11
Reflector, Cold Cal. Position, LSP, First Reading	Word 11
Reflector, Cold Cal. Position, MSP, Second Reading	Word 12
Reflector, Cold Cal. Position, LSP, Second Reading	Word 12
Warm Cal. Position, Channel 1, MSP	Word 13
Warm Cal. Position, Channel 1, MSP	Word 13
Warm Cal. Position, Channel 2, MSP	Word 14
Warm Cal. Position, Channel 2, MSP	Word 14

Words 11 through 14 are repeated 29 times for a total of 30 data sets.

Temp Sensor 1, MSP	Word 131
Temp Sensor 1, LSP	Word 131
Temp Sensor 2, MSP	Word 132
Temp Sensor 2, LSP	Word 132

See Figure 13

Temp Sensor 19, MSP	Word 149
Temp Sensor 19, LSP	Word 149
Temp Sensor Reference Voltage, MSP	Word 150
Temp Sensor Reference Voltage, LSP	Word 150

NOTES:

1. In the above table, the MSP is the most significant portion of a particular measurement while the LSP is the least significant portion of a particular measurement.
2. In the above table, the first set of readings for a particular reflector position are made prior to the integration interval, while the second set of readings are made approximately half way through the integration period.
3. Digital A data as read by the spacecraft shall contain an undetermined number of fill words. These fill words shall be 0001H and will be intermingled with valid data. The Digital A data as sent by the instrument shall be such that no valid data of 0001H shall be included.
4. Format of Position data is: DDDDDDDDDDDDDDE0, where
   D = Data
   E = Error bit, 0 = not in spec, 1 = in spec
   0 = Zero
5. Format of Radiometer data is: DDDDDDDDDDDDDDD0. where
   D = Data and 0 = Zero
6. The temperature sensor reference voltage is utilized for temperature sensors 13 through 19 only.

Figure 9 Cold Cal Mode, Unit A2

Parameter	
Reflector 1, Position 15, MSP, First Reading	Word 11
Reflector 1, Position 15, LSP, First Reading	Word 11
Reflector 2, Position 15, MSP, First Reading	Word 12
Reflector 2, Position 15, LSP, First Reading	Word 12
Reflector 1, Position 15, MSP, Second Reading	Word 13
Reflector 1, Position 15, LSP, Second Reading	Word 13
Reflector 2, Position 15, MSP, Second Reading	Word 14
Reflector 2, Position 15, LSP, Second Reading	Word 14
Nadir Position, Channel 3, MSP	Word 15
Nadir Position, Channel 3, LSP	Word 15
Nadir Position, Channel 4, MSP	Word 16
Nadir Position, Channel 4, LSP	Word 16

Nadir Position , Channel 15, MSP	Word 27
Nadir Position , Channel 15, LSP	Word 27

Words 11 through 27 are repeated 29 times for a total of 30 data sets.

Temp Sensor 1, MSP	Word 521
Temp Sensor 1, LSP	Word 521
Temp Sensor 2, MSP	Word 522
Temp Sensor 2, LSP	Word 522

Temp Sensor 45, MSP	Word 565
Temp Sensor 45, LSP	Word 565
Temp Sensor Reference Voltage, MSP	Word 566
Temp Sensor Reference Voltage, LSP	Word 566

See Figure 12

NOTES:

1. In the above table, the MSP is the most significant portion of a particular measurement while the LSP is the least significant portion of a particular measurement.
2. In the above table, the first set of readings for a particular reflector position are made prior to the integration interval, while the second set of readings are made approximately half way through the integration period.
3. Digital A data as read by the spacecraft shall contain an undetermined number of fill words. These fill words shall be 0001H and will be intermingled with valid data. The Digital A data as sent by the instrument shall be such that no valid data of 0001H shall be included.
4. Format of Position data is: DDDDDDDDDDDDDDE0, where
   D = Data
   E = Error bit, 0 = not in spec, 1 = in spec
   0 = Zero
5. Format of Radiometer data is: DDDDDDDDDDDDDDD0. where
   D = Data and 0 = Zero
6. The temperature sensor reference voltage is utilized for temperature sensors 13 through 19 only.

Figure 10 Nadir Mode, Unit A1

Parameter	
Reflector, Position 15, MSP, First Reading	Word 11
Reflector, Position 15, LSP, First Reading	Word 11
Reflector, Position 15, MSP, Second Reading	Word 12
Reflector, Position, 15 LSP, Second Reading	Word 12
Nadir Position, Channel 1, MSP	Word 13
Nadir Position, Channel 1, MSP	Word 13
Nadir Position, Channel 2, MSP	Word 14
Nadir Position, Channel 2, MSP	Word 14

Words 11 through 14 are repeated 29 times for a total of 30 data sets.

Temp Sensor 1, MSP	Word 131
Temp Sensor 1, LSP	Word 131
Temp Sensor 2, MSP	Word 132
Temp Sensor 2, LSP	Word 132

Temp Sensor 19, MSP	Word 149
Temp Sensor 19, LSP	Word 149
Temp Sensor Reference Voltage, MSP	Word 150
Temp Sensor Reference Voltage, LSP	Word 150

See Figure 13

NOTES:

1. In the above table, the MSP is the most significant portion of a particular measurement while the LSP is the least significant portion of a particular measurement.
2. In the above table, the first set of readings for a particular reflector position are made prior to the integration interval, while the second set of readings are made approximately half way through the integration period.
3. Digital A data as read by the spacecraft shall contain an undetermined number of fill words. These fill words shall be 0001H and will be intermingled with valid data. The Digital A data as sent by the instrument shall be such that no valid data of 0001H shall be included.
4. Format of Position data is: DDDDDDDDDDDDDDE0, where
   D = Data
   E = Error bit, 0 = not in spec, 1 = in spec
   0 = Zero
5. Format of Radiometer data is: DDDDDDDDDDDDDDD0. where
   D = Data and 0 = Zero
6. The temperature sensor reference voltage is utilized for temperature sensors 13 through 19 only.

Figure 11 Nadir Mode, Unit A2

DATA WORD	FUNCTION MONITORED	NOMINAL COUNTS	ALERT THRESHOLD COUNTS	IMMEDIATE ACTION COUNTS
1	Primary Header - Packet ID			
2	Primary Header - Packet Sequence Control			
3	Primary Header - Packet Length			
4	Secondary Header			
5	Secondary Header			
6	Secondary Header			
7	Secondary Header			
8	Secondary Header (Plus one dummy zero byte)			
9	Unit Serial Number			
10	Instrument Mode and Relay Status	See Note 1		
11	Reflector Position (A1-1 Antenna)	See Note 2		
12	Reflector Position (A1-2 Antenna)	See Note 2		
13	1 Scan Motor A1-1 Temperature	16380	±10920	±16380
14	2 Scan Motor A1-2 Temperature	16380	±10920	±16380
15	3 Signal Processor Temperature	16380	±10920	±16380
16	4 Radiator Panel Temperature	16380	±10920	±16380
17	5 RF Mux - A1-1 Temperature	16380	±10920	±16380
18	6 RF Mux - A1-2 Temperature	16380	±10920	±16380
19	7 Local Oscillator - Channel 3 Temperature	16380	±10920	±16380
20	8 Local Oscillator - Channel 4 Temperature	16380	±10920	±16380
21	9 Local Oscillator - Channel 5 Temperature	16380	±10920	±16380
22	10 Local Oscillator - Channel 6 Temperature	16380	±10920	±16380
23	11 Local Oscillator - Channel 7 Temperature	16380	±10920	±16380
24	12 Local Oscillator - Channel 8 Temperature	16380	±10920	±16380
25	13 Phase Locked Oscillator No. 1 Temperature	16380	±10920	±16380
26	14 Phase Locked Oscillator No. 2 Temperature	16380	±10920	±16380
27	15 Phase Locked Oscillator Ref Temperature	16380	±10920	±16380
28	16 Local Oscillator - Channel 15 Temperature	16380	±10920	±16380
29	17 Mixer/IF Amplifier - Channel 3 Temperature	16380	±10920	±16380
30	18 Mixer/IF Amplifier - Channel 4 Temperature	16380	±10920	±16380
31	19 Mixer/IF Amplifier - Channel 5 Temperature	16380	±10920	±16380
32	20 Mixer/IF Amplifier - Channel 6 Temperature	16380	±10920	±16380
33	21 Mixer/IF Amplifier - Channel 7 Temperature	16380	±10920	±16380
34	22 Mixer/IF Amplifier - Channel 8 Temperature	16380	±10920	±16380
35	23 Mixer/IF Amplifier - Channel 9/14 Temp	16380	±10920	±16380
36	24 Mixer/IF Amplifier - Channel 15 Temp	16380	±10920	±16380
37	25 IF Amp - Channel 11/14 Temperature	16380	±10920	±16380
38	26 IF Amp - Channel 9 Temperature	16380	±10920	±16380
39	27 IF Amp - Channel 10 Temperature	16380	±10920	±16380
40	28 IF Amp - Channel 11 Temperature	16380	±10920	±16380
41	29 IF Amp - Channel 12 Temperature	16380	±10920	±16380
42	30 IF Amp - Channel 13 Temperature	16380	±10920	±16380
43	31 IF Amp - Channel 14 Temperature	16380	±10920	±16380
44	32 DG/DC Converter Temperature	16380	±10920	±16380
45	33 RF Shelf - A1-1 Temperature	16380	±10920	±16380

Figure 12 EOS/AMSU-A1 Engineering Data Format - Expected Values - And Ranges (Sheet 1 of 2)

DATA WORD	FUNCTION MONITORED	NOMINAL COUNTS	ALERT THRESHOLD COUNTS	IMMEDIATE ACTION COUNTS
46	34 RF Shelf - A1-2 Temperature	16380	±10920	±16380
47	35 Detector/Preamplifier Temperature	16380	±10920	±16380
48	36 A1-1 Warm Load 1 Temperature	19650	±6550	±13100
49	37 A1-1 Warm Load 2 Temperature	19650	±6550	±13100
50	38 A1-1 Warm Load 3 Temperature	19650	±6550	±13100
51	39 A1-1 Warm Load 4 Temperature	19650	±6550	±13100
52	40 A1-1 Warm Load Center Temperature	19650	±6550	±13100
53	41 A1-2 Warm Load 1 Temperature	19650	±6550	±13100
54	42 A1-2 Warm Load 2 Temperature	19650	±6550	±13100
55	43 A1-2 Warm Load 3 Temperature	19650	±6550	±13100
56	44 A1-2 Warm Load 4 Temperature	19650	±6550	±13100
57	45 A1-2 Warm Load Center Temperature	19650	±6550	±13100
58	PRT Reference Voltage	?	?	?
59	Signal Processor +5 Volts	21816	±1092	±2185
60	Signal Processor +15 Volts	21989	±2180	±4362
61	Signal Processor -15 Volts	21758	±1088	±2176
62	Scan Drive +5 Volts	21816	±1092	±2185
63	Scan Drive +15 Volts	21989	±2180	±4362
64	Scan Drive -15 Volts	21758	±1088	±2176
65	PLO +15 Volts	21989	±436	±872
66	PLO -15 Volts	21758	±1088	±2176
67	Receiver +8 Volts	21498	±305	±610
68	Mixer/IF Amplifier - A1-1 +10 Volts	21468	± 85	±175
69	Mixer/IF Amplifier - A1-2 +10 Volts	21468	± 85	±175
70	Local Oscillator - Channel 6 +10 Volts	21468	±1755	±3510
71	Local Oscillator - Channel 7 +10 Volts	21468	±1755	±3510
72	Local Oscillator - Channel 15 +10 Volts	21468	±1755	±3510
73	Local Oscillator - Channel 3 +10 Volts	21468	±1755	±3510
74	Local Oscillator - Channel 4 +10 Volts	21468	±1755	±3510
75	Local Oscillator - Channel 5 +10 Volts	21468	±1755	±3510
76	Local Oscillator - Channel 8 +10 Volts	21468	±1755	±3510
77	Amplifier CH15 +5 Volts	21816	±218	±436
78	A1 Quiet Bus Current	21845	±2185	±4370
79	A1-1 Noisy Power Bus Current	20280	±2030	±4060
80	A1-2 Noisy Power Bus Current	20280	±2030	±4060

Note 1 : This Word Contains 12 Active Bits Designated As Shown In The Following Table

FUNCTION	STATES	BITS
A1-1 Scan Power Relay	On or Off	1
A1-2 Scan Power Relay	On or Off	1
PLLO Pri / Rdt Relay	Primary or Redundant	1
Cold Cal Position	0, 1, 2, or 3	2
ADC Latchup Flag	High or Low	1
Primary PLO Lock	Locked or Unlocked	1
Redundant PLO Lock	Locked or Unlocked	1
Instrument Modes	Full Scan, Nadir, Warm Cal, Cold Cal, No Mode	4

Note 2 : The Reflector Position Value Depends On Instrument Mode - And Is Not Valid In Full Scan Mode

Figure 12 EOS/AMSU-A1 Engineering Data Format - Expected Values - And Ranges (Sheet 2 of 2)

DATA WORD	FUNCTION MONITORED	NOMINAL COUNTS	ALERT THRES-HOLD COUNTS	IMMEDIATE ACTION COUNTS
1	Primary Header - Packet ID			
2	Primary Header - Packet Sequence Control			
3	Primary Header - Packet Length			
4	Secondary Header			
5	Secondary Header			
6	Secondary Header			
7	Secondary Header			
8	Secondary Header (Plus one dummy zero byte)			
9	Unit Serial Number			
10	Instrument Mode and Relay Status	See Note 1		
11	Reflector Position	See Note 2		
12	1 Scan Motor Temperature	16380	± 10920	± 16380
13	2 Signal Processor Temperature	16380	± 10920	± 16380
14	3 RF Diplexer Temperature	16380	± 10920	± 16380
15	4 Mixer/IF Amplifier - Channel 1 Temperature	16380	± 10920	± 16380
16	5 Mixer/IF Amplifier - Channel 2 Temperature	16380	± 10920	± 16380
17	6 Local Oscillator - Channel 1 Temperature	16380	± 10920	± 16380
18	7 Local Oscillator - Channel 2 Temperature	16380	± 10920	± 16380
19	8 Radiator Panel Temperature	16380	± 10920	± 16380
20	9 Subreflector Temperature	16380	± 10920	± 16380
21	10 DC/DC Converter Temperature	16380	± 10920	± 16380
22	11 RF Shelf - Temperature	16380	± 10920	± 16380
23	12 Detector/Preamplifier Temperature	16380	± 10920	± 16380
24	13 Warm Load 1 Temperature	19650	± 6550	± 13100
25	14 Warm Load 2 Temperature	19650	± 6550	± 13100
26	15 Warm Load 3 Temperature	19650	± 6550	± 13100
27	16 Warm Load 4 Temperature	19650	± 6550	± 13100
28	17 Warm Load 5 Temperature	19650	± 6550	± 13100
29	18 Warm Load 6 Temperature	19650	± 6550	± 13100
30	19 Warm Load Center Temperature	19650	± 6550	± 13100
31	PRT Reference Voltage	?	?	?
32	Signal Processor +5 Volts	21816	± 1092	± 2185
33	Signal Processor +15 Volts	21989	± 2180	± 4362
34	Signal Processor -15 Volts	21758	± 1088	± 2176
35	Scan Drive +5 Volts	21816	± 1092	± 2185
36	Scan Drive +15 Volts	21989	± 2180	± 4362
37	Scan Drive -15 Volts	21758	± 1088	± 2176
38	Receiver +8 Volts	21498	± 305	± 610
39	Mixer/IF Amplifier +10 Volts	21468	± 85	± 175
40	Local Oscillator - Channel 1 +10 Volts	21468	± 1755	± 3510
41	Local Oscillator - Channel 2 +10 Volts	21468	± 1755	± 3510
42	A2 Quiet Bus Current	21845	± 2185	± 4370
43	A2 Noisy Power Bus Current	20280	± 2030	± 4060

Note 1 : This Word Contains 8 Active Bits Designated As Shown In The Following Table

FUNCTION	STATES	BITS
Scan Power Relay	On or Off	1
Cold Cal Position	0, 1, 2, or 3	2
ADC Latchup Flag	High or Low	1
Instrument Modes	Full Scan, Nadir, Warm Cal, Cold Cal, No Mode	4

Note 2 : The Reflector Position Value Depends On Instrument Mode - And Is Not Valid In Full Scan Mode

Figure 13 EOS/AMSU-A2 Engineering Data Format - Expected Values - And Ranges

Table II Low Rate Science Data Group Parameters

Data	Data Element	Definition	Validity Check Require-ment	Parameteri-zation Requirement	Format or Implementation Restrictions
Reflector Position	Reflector data at each beam position + cold and warm calibrate beam positions	Reflector positions: 2* antenna (2 look angles)	Bit #2: 0=not in spec, 1= in spec	Voltage counts	16 bit integer
Scene Radiometric	Channel radiometric data	Channel # 3-15**) radiometric data at beam positions 1-30	None	Voltage counts	16 bit integer
Calibrate Data	Scan warm calibration data	Channel warm calibration data (Ch #3-15**) at warm cal beam position	None	Voltage counts	16 bit integer
	Scan cold calibrate data	Channel cold calibration data (Ch #3-15**) at cold cal beam position	None	Voltage counts	16 bit integer
Warm Load Temperature	CTE PRT Group Data (Warm Load PRT) data	Warm load temperature values 1-10***	None	Temperature resistance counts	16 bit integer

Notes: * Unit A1 has 2 antennas and A2 has only 1 antenna.
** Unit A1 uses channels 3-15 and A2 uses 1 and 2.
*** Unit A1 uses temperature values 1-10 and A2 uses 1-7.

5.1.1.2 Calibration Test Equipment Data

5.1.1.2.1 Unit Data Structure. CTE data is output to firmware for transfer across the STE interface. The data are comprised of 2 data types (Platinum Resistance Thermometers and Thermocouple Data) which are transferred at different rates across 2 distinct ports. The data shall be accessed by the STE at approximate 8 second scan intervals.

5.1.1.2.1.1 CTE PRT and Thermocouple Group Data. PRT data received from the CTE shall include thermometer temperatures. For Unit A1 Thermometer temperatures: 2 antennas look at 2 targets (cold load and scene); each target has 7 PRTs for a total of 28 PRTs. For Unit A2 Thermometer temperatures: 1 antenna looks at 2 targets (cold load and scene); each target has 11 PRTs for a total of 22 PRTs. Data acquisition shall begin after the operator enables input through the STE software. The transfer will be via RS-232 transfer across the instrument CTE-STE interface.

A1 Word No.	Parameter
10	Digital Telemetry Data 1
10	Digital Telemetry Data 2

Figure 14 Engineering Data (Digital) Telemetry Data), Unit A1

Digital Bit	Telemetry Data, Byte Number 1 Description
0	0
1	Full Scan Mode. 0 = Not Full Scan, 1= Full Scan
2	Warm Cal Mode. 0 = Not in Warm Cal, 1 = Warm Cal
3	Cold Cal Mode. 0 = Not in Cold Cal, 1 = Cold Cal
4	Nadir Mode. 0 = Not in Nadir, 1 = Nadir
5	Cold Cal Position, LSB
6	Cold Cal Position, MSB
7	0
Digital Bit	**Telemetry Data, Byte Number 2 Description**
0	0
1	Scanner A1-1 Power. 0 = Off, 1 = On
2	Scanner A1-2 Power 0 = Off, 1 = On
3	PLL Power. 0 = Redundant, 1 = Primary
4	Survival Heater Power. 0 = Off, 1 = On
5	0
6	0
7	0

Figure 15 Digital Telemetry Data, Unit A1

Digital Bit	Telemetry Data, Byte Number 1 Description
0	0
1	Full Scan Mode. 0 = Not Full Scan, 1= Full Scan
2	Warm Cal Mode. 0 = Not in Warm Cal, 1 = Warm Cal
3	Cold Cal Mode. 0 = Not in Cold Cal, 1 = Cold Cal
4	Nadir Mode. 0 = Not in Nadir, 1 = Nadir
5	Cold Cal Position, LSB
6	Cold Cal Position, MSB
7	0
Digital Bit	**Telemetry Data, Byte Number 2 Description**
0	0
1	Scanner A1-1 Power. 0 = Off, 1 = On
2	Scanner A1-2 Power 0 = Off, 1 = On
3	PLL Power. 0 = Redundant, 1 = Primary
4	Survival Heater Power. 0 = Off, 1 = On
5	0
6	0
7	0
Digital Bit	**Telemetry Data, Byte Number 3 Description**
0	0
1	0
2	0
3	0
4	0
5	0
6	0
7	0
Digital Bit	**Telemetry Data, Byte Number 4 Description**
0	0
1	0
2	0
3	0
4	0
5	0
6	0
7	0

Figure 16 Digital Telemetry Data, Unit A2

Table III Digital Telemetry Data Group Parameters

Data	Data Element	Definition	Validity Check Require-ment	Parameteri-zation Requirement	Format or Implementation Restrictions
Digital Telemetry Data	Scanner Power	Power relay statuses for scanners (1 & 2)* - On or Off	None	Binary On /Off	2 bits
	Scanner Mode	Antenna position - On/Off status for instrument modes: 1) Warm Cal mode; 2) Cold Cal mode; 3) Nadir mode; 4) Full Scan mode; 5) No mode	None	Binary On/Off	4 bits
	Cold calibration position	Antenna position at the cold cal beam position 1-4	None	Positions	2 bits
	Primary Phased Lock Loop Oscillator (PLLO) Lock**	Lock or Unlocked	None	Binary On/Off	1 bit
	Redundant PLLO Lock **	Locked or Unlocked	None	Binary On/Off	1 bit
	Heater Power	On or Off	None	Binary On/Off	1 bit

Notes: * Unit A1 has antenna 1 & 2 and A2 has only 1 antenna.
** Only Unit has primary PLLO Lock and Redundant PLLO Lock.

Table IV Temperature Data Group Parameters

Data	Data Element	Definition	Validity Check Require-ment	Parameteri-zation Requirement	Format or Implementation Restrictions
PRT Temperature Data	PRT data	Thermometer values (1-35 evaluated for each antenna)*	None	Temperature resistance counts	16 bit integer

Note: *Unit A1 has thermometer values 1-35 for each of the 2 antennas and A2 has values 1-12 for the 1 antenna.

Table V Unpowered PRTs Parameters

Data	Validity Check Require-ment	Parameteri-zation Requirement	Format or Implementation Restrictions
Antenna scanner motor temperature	None	Voltage counts	8 bit integer
Radio Frequency (RF) Shelf Temperature	None	Voltage counts	8 bit integer
Warm Load temperature	None	Binary On/Off	8 bits

Thermocouple data received from the CTE shall include temperature data from the CTE Thermal Control System. Data acquisition shall begin after the operator enables input through the STE software. The transfer will be via RS-232 transfer across the instrument CTE-STE interface. Additional Data information is found in Table VI.

5.1.2 Transactions, Including Algorithms

5.1.2.1 Sensor Transaction. Sensor transaction shall convert PRT voltage counts to temperature and convert analog counts to engineering units.

5.1.2.2 CTE Transaction. The statistical and tolerance measurements in the following paragraphs shall be computed to demonstrate system performance and in-orbit calibration.

5.1.2.2.1 Calibration Correction Factor. The calibration correction factor measures the difference between Warm Load radiometric and physical temperature. It shall be computed as follows:

a. Set the variable target temperature to the internal warm load temperature and allow it to stabilize in temperature. The internal warm load physical temperature is determined via the in-flight PRTs.

b. Calculate the in-flight radiometric temperature using the following formula:

$$Tw = Tv + (Tv - Tc)X\frac{(Nw - Nv)}{(Nv - Nc)}$$

Table VI CTE PRT and Thermocouple Group Data Parameters

Data	Data Element	Definition	Validity Check Require-ment	Parameteri-zation Requirement	Format or Implementation Restrictions
Scene target PRTs	N/A	For Unit A1: 7 scene PRTs looked at by each of 2 antennas; Total = 14. For Unit A2: 11 scene PRTs looked at by each antenna; Total = 11	None	Temperature resistance counts	8 bit integer
Fixed (cold) target PRTs	N/A	For Unit A1: 7 cold target PRTs looked at by each of 2 antennas; Total - 14. For Unit A2: 11 cold target PRTs looked at by each antenna; Total - 11.	None	Temperature resistance counts	8 bit integer
CTE Thermo-couples	N/A	For Unit A1: 17 thermocouples from Thermal Control System - Fixed (cold) target has 5, Scene (variable) target has 7, Baseplate (warm) target has 5. For Unit A2: 21 thermocouples - including the additional Adjunct radiator which has 4.	None	Temperature resistance counts	8 bit integer

Unit A1

Number	Parameter
1	No. 1 Antenna Drive Motor Current (Peak)
2	No. 2 Antenna Drive Motor current (Peak)
3	Radiometer, Receiver, Signal Processing + 15 Vdc
4	Antenna Drive + 15 Vdc
5	No. 1 -15 Vdc
6	No. 2 -15 Vdc
7	+ 8 Vdc
8	No. 1 +5 Vdc
9	No. 2 +5 Vdc
10	Variable +5 Vdc
11	Phase Lock Loop No. 1 Variable +5 Vdc
12	Phase Lock Loop No. 2 Variable +5 Vdc
13	DRO No. 1 Variable +3.7 Vdc
14	DRO No. 2 Variable +3.7 Vdc
15	DRO No. 3 Variable +3.7 Vdc
16	DRO No. 4 Variable +3.7 Vdc
17	DRO No. 5 Variable +3.7 Vdc
18	DRO No. 6 Variable +3.7 Vdc
19	No. 1 Beam Position Error
20	No. 2 Beam Position Error
21-39	Unpowered PRTs

Unit A2

Number	Parameter
1	No. 1 Antenna Drive Motor Current (Peak)
2	Radiometer, Receiver, Signal Processing + 15 Vdc
3	Antenna Drive + 15 Vdc
4	No. 1 -15 Vdc
5	No. 2 -15 Vdc
6	+ 8 Vdc
7	No. 1 +5 Vdc
8	No. 2 +5 Vdc
9	DRO No. 1 Variable +7.5 Vdc
10	DRO No. 2 Variable +3.7 Vdc
11	No. 1 Beam Position Error
12-30	Unpowered PRTs

Figure 17 Engineering Data (Current/Voltage Group), Unit A1 and Unit A-2

where: Tw = The radiometric temperature of the in-flight warm load

Tv = The physical temperature of the variable target (A1:average of 7 PRTs) (A2:average of 11 PRTs)

Tc = The physical temperature of the fixed space target (A1:average of 7 PRTs) (A2:average of 11 PRTs)

Nw = The average of two internal warm load counts

Nc = The average of two fixed target counts

Nv = The variable target counts

c. The warm load radiometric temperature, Tw, is compared to the physical temperature, Tw', to calculate the correction factor:

$$Tw2 = Tw - Tw'$$

where: Tw2 = Warm load calibration correction factor

Tw = Average of 3600 radiometric temperature samples

Tw' = Average of 3600 physical temperature samples (Each sample an average of PRTs: A1: 7 PRTs; A2: 11 PRTs)

5.1.2.2.2 **Gain Drift**. The short term gain drift, delta-G/G, of the instrument shall be computed as follows:

Accomplish gain drift for 3 different positions: 1) Nominal instrument temperature, 2) Nominal baseplate temperature, and 3) Warmest temperature (330K) for the Engineering Model cycle.

Table VII below describes the process scenario to follow to determine gain drift:
(Note: See section on NEΔT below for an explanation of 10-10-10 scan)

Table VII Process Scenario to Determine Gain Drift

Quantity	Sample	Time (seconds)
1	10-10-10	
26	Dwell at Beam Position (BP) #6 with compressed minor frame	208 = t0
1	10-10-10 scan	8
	Total Time	224
	Sample Frequency	0.2

Short term gain drifts are difficult to characterize because NEΔT effects co-exist with the short term drift. Sample averaging shall be employed to reduce these NEΔT effects. This technique, however, will reduce the frequency range of a test.

By following Table VII sampling, required temperature data (25 PRTs) and channel radiometer shall be retrieved.

Store acquired radiometer data into arrays as follows:

a. For channel radiometric data,

$$x(i + 40(j - 1)) = \overline{x(i)} - \bar{x}$$

Where: $\overline{xi}$ = The ith (1 to 40) calculated radiometric temperature of channel output in the jth minor frame (1 to 26) using the average of the pre and post data 10-10-10 scans.

$\bar{x}$ = The mean of all 1024 data elements (the 40th sample can not be obtained; therefore, it is synthesized by the following equation:)

$$x(40) = x(39) + ((-1) * *j) * (NE\Delta T / 2)$$

b. For temperature data,

$$x(i + 40(j - 1)) = \overline{X(i)} - \overline{X}$$

Where: $\overline{xi}$ = The calculated temperature of the particular element (1 to 25)

$\bar{x}$ = The mean of all 25 elements

Transform the data arrays for both channel radiometric data and temperature data to the frequency domain by using FFT (Fast Fourier Transform).

$$x(i) \xrightarrow{\text{FFT}} = x(n)$$

This transformation will provide the frequency spectrum of the radiometer drift.

To satisfy performance requirements, drift amplitudes shall not exceed derived specifications.

NOTE

Frequencies above 2.5 Hz shall not be represented since it is the Nyquist critical frequency. Frequencies below 0.125 Hz may not be of significance since eight seconds is the scan period for a given calibration.

Table VIII shows FFT performance.

5.1.2.2.3 **NEΔT**. The NEΔT measures the radiometric thermal noise associated with variable target measurements (time averaged to reduce gain drift). It shall be computed as follows:

System NEΔT shall be calculated for all radiometer channels while viewing a 300 K target (performance specification baseline). However, to enable further assessment of instrument performance, thermal-vacuum calibration shall be computed over the total dynamic range of target temperatures (84 K to 330 K).

Table VIII FFT Performance

Variables	Radiometric
Frequency resolution, 1/(N*delta-t)	0.00488 Hz
Number of data points, N	1024
Frequency limit, N/(2*delta-t) (Nyquist Frequency)	2.5 Hz
Worst case amplitude accuracy	Temperature Root Squared Sum

The instrument shall acquire data from 3 targets in a 10-10-10 configuration mode as follows:

a. When the 8-second frame synchronization pulse (FSP) appears, accomplish the following:

   1. The antenna points to the variable target: take 10 samples

   2. The antenna scans to the fixed 84 K target; take 10 samples

   3. The antenna scans to the internal warm load; take 10 samples

   4. The antenna returns to the variable target, awaiting a FSP

b. STE software shall configure buffers to enable data retrieval and storage compatible with the orbital sampling sequence.

   Variable Target
   1 2 3 4 5 6 7 8 9 10

   Fixed 84 K Target
   1 2 3 4 5 6 7 8 9 10

   Internal Warm Load
   1 2 3 4 5 6 7 8 9 10

c. Compute NEΔT at earth scene position six, where the CTE variable target is positioned.

   NEΔT shall be defined as the standard deviation of the target radiometric temperature computed over 360 scans (3600 samples based on 10-120-10 sample configuration), applying a least squares linear fit to a running sample of N scans (N can range between 1 and 100).

d. Compute the target radiometric temperature over 360 scans (3600 samples based on 10-10-10 sample configuration), applying a least squares linear fit to a running sample of N scans.

   (Linear fit variables computed over N scans; Cs pertains to scan)

$$Ts = \overline{Tw} + \frac{(\overline{Tc} - \overline{Tw})(Cs - \overline{Cw})}{(\overline{Cc} - \overline{Cw})}$$

Where: Ts = Target radiometric temperature (at each scan)
(Variable target at BP#6)

$\overline{Tw}$ = Calibrated warm load physical temperature
(each sample an average of PRTs: A1 - 7 PRTs , A2-11 PRTs)
determined by linear fit data.

$\overline{Tc}$ = Fixed space target physical temperature
(each sample an average of PRTs:A1 - 7 PRTs,A2 - 11 PRTs)
determined by linear fit data.

Cs = Analog/Digital counts corresponding to the radiometric variable earth target temperature.

$\overline{Cw}$ = Analog/Digital counts corresponding to warm load determined by linear fit data.

$\overline{Cc}$ = Analog/Digital counts corresponding to fixed space target brightness temperatures determined by linear fit data.

5.1.2.2.4 Calibration Accuracy. Calibration accuracy describes how well the radiometric temperature (time averaged to reduce gain drift) estimates the physical temperature of a calibration target. Unlike the NEΔT, the performance specification for calibration accuracy is defined over the total dynamic range of target temperatures, 84 K to 330 K. The accuracy tolerance shall be 1 K per step temperature. Calibration accuracy shall be computed as follows:

$$Ac[time] = Tv - Tr$$

Where: Ac[time] = Calibration Accuracy (time averaged using running sample of N scans in Tv computations)

Tv = Radiometric temperature of the variable target based on 360 scans-same as computations for Ts)

Tr = Physical temperature of the variable target based on 360 scans-average of target PRTs)

Updates to calibration accuracies shall coincide with updates to NEΔTs (360 scans).

5.1.2.2.5 Load Stability. Load stability values measure the range of target radiometric temperatures computed, for 1 and 2 targets. It shall be computed as follows:

$$Ls = Ts[max] - Ts[min] \ (1\ target)$$

$$Ls = Tv[max] - T[min] \ (2\ targets)$$

Where: Ls = Load Stability

Ts[max] or Tv[max] = Max target radiometric temperature (based on 360 scans)

Ts[min] or Tv[min] = Min target radiometric temperature (based on 360 scans)

5.1.2.2.6 Instrument Temperature Stability. Instrument temperature stability measures the range of RF shelf temperatures. It shall be computed as follows:

$$ITS = RFT[max] - RFT[min]$$

where: ITS = instrument temperature stability

RFT[max] = Max RF shelf temperature (based on 360 scans)

RFT[min] = Min RF shelf temperature (based on 360 scans)

5.1.2.2.7 Warm Load to Variable Load Delta. Warm load to variable load delta measures the temperature difference between averaged warm load and variable target temperatures. It shall be computed as follows:

$$Tw\_Del = Tw\_Avg - Tv\_Avg$$

where: Tw_Del = Warm load to variable target temperature delta

Tw_Avg = Average physical temperature of the warm load (averaged over 360 scans)

Tv_Avg = Average radiometric temperature of the variable target (averaged over 360 scans)

5.1.2.2.8 Calibration Accuracy (3 types). Three types of calibration accuracy (instantaneous, subcycle average, and cycle average) measure how well the radiometric temperature estimates the physical temperature of a calibration target, computed for variable target temperatures that range from 84 K to 330 K. The instantaneous calibration accuracy is determined by the difference between the radiometric and physical temperature of the variable target (average of variable target PRTs).

The instantaneous calibration accuracy shall be computed as follows:

$$Ac[inst] = Tr - Ts$$

where: Ac[inst] = Calibration accuracy (instantaneous) for a given target temperature

Tr = Physical temperature of the variable target (BP #6)

Ts = Radiometric temperature of the variable target (BP #6)

The subcycle averaged calibration accuracy shall be computed as follows:

$$Ac[s\_avg] = \frac{Sum\_Ac[inst]}{S - N[deg]}$$

where: Ac[s_avg] = Calibration accuracy (subcycle average) for a given target temperature

Sum_Ac[inst] = Sum of instantaneous calibration accuracies (BP #6)

S = Sample size – 3600 samples (360 scans)

N[deg] = Number of scans used in computing linear fit estimate of Ts radiometric temperatures - 1 (i.e. if 7 scans, then N=6)

The cycle averaged calibration accuracy shall be computed as follows:

$$Ac[c\_avg] = \frac{Sum\_Ac[s\_avg]}{N[sc]}$$

where: Ac[c_avg] = Calibration accuracy (cycle average) for a given temperature

Sum_Ac[s_avg] = Sum of subcycle calibration accuracies (BP #6)

N[sc] = Number of subcycles

5.1.2.2.9 Calibration Repeatability. The two types of calibration accuracy (instantaneous and cycle average) measure the standard deviation of calibration accuracies to averaged calibration accuracies computed for variable target temperatures that range from 84 K to 330 K.

The instantaneous calibration repeatability shall be computed as follows:

a. Compute averaged instantaneous calibration accuracy

$$Ac[inst\_avg] = 1/2\ x\ (Ac(j) + Ac(J+1))$$

where: Ac[inst_avg] = Instantaneous calibration accuracy averaged over 2 scans (j,j+1) for a given target temperature (BP #6)

Ac(j) = Instantaneous calibration accuracy at scan j

Ac(j+1) = Instantaneous calibration accuracy at scan j+1

b. Compute scan calibration repeatability

$$Rc[scan] = Ac[inst\_avg] - Ac[s\_avg]$$

where: Rc[scan] = Scan calibration repeatability for a given target temperature (BP #6)

ac[inst_avg] = Instantaneous calibration accuracy averaged over 2 scans (j,j+1)

ac[s_avg] = Calibration accuracy (subcycle average)

c. Compute instantaneous calibration repeatability

$$Rc[inst] = Std\_Rc[scan]$$

where: Rc[inst] = instantaneous calibration repeatability for a given target temperature (BP #6)

Std_Rc[scan] = Standard deviation of scan calibration repeatability computed over all samples (360 samples).

The cycle averaged calibration repeatability shall be computed as follows:

$$Rc[c\_avg] = \frac{1}{NsxNt} x\ Sum\_Sum\_Rc[inst]$$

where: Rc[c_avg] = cycle averaged calibration repeatability for a given target temperature (BP #6)

Sum_Sum_Rc[inst] = Sum of instantaneous calibration repeatabilities over all subcycles and computed for each variable target temperature (range: 84 K to 330 K)

Ns = Number of subcycles

Nt = Number of variable target temperatures.

5.1.2.2.10 Linearity. Linearity measures how well can linear functions describe the radiometer transfer function, computed for variable target temperatures that range from 84 K to 330 K. The linearity shall be computed as follows:

$$Lin = Ac[s\_avg] - Ac[reg]$$

where: Lin = Linearity of the radiometer receiver for a given target temperature

Ac[s_avg] = Subcycle averaged calibration accuracy

Ac[reg] = Regression linear fit estimate of Ac.

5.1.3 Output Data and Destination. Output data from the instrument and CTE shall be saved to output media to facilitate operator inspection. This output shall include:

5.1.3.1 Display Data On Video Terminal. Display data for the Cathode Ray Tube (CRT) shall include the following displays:

5.1.3.1.1 Display Instrument Low Rate Science Data. This display data shall include the following data:

a. Raw Beam Position

b. Single Beam Position

c. All Beam Position

d. Reflector Position

e. Temperature

f. Warm Calibrate

g. Cold Calibrate

5.1.3.1.2 Display Instrument Engineering Data. This display shall include the following data:

a. Digital Telemetry Status

b. Current/Voltage

5.1.3.1.3 Display CTE Data. This display data shall include the following temperatures:

a. Thermocouple temperatures

b. PRT Temperatures

c. N2 Temperatures.

5.1.3.1.4 Display Unpowered PRTs. This display data will include the temperature data obtained when power is not applied to the instrument.

5.3.1.5 Display Data Stored On Disk. All input instrument and CTE data shall be recorded on the system disk. Names of disk files shall be unique to the instrument test performed. The operator shall be able to select a specified file (in accordance with file-naming convention) for CRT display. Data stored on system disk shall be formatted for later retrieval, enabling data display and recycling through calibration algorithms.

5.1.3.1.6 Display Data Stored On Magnetic Tape. The operator shall be able to select a file stored on magnetic tape for data display and recycling through calibration algorithms.

5.1.3.1.7 Display Data Errors. See section on Error Handling and Table IX for error identification. Display of data errors shall include:

a. Error messages shall be displayed for occurrences of bad or out-of-tolerance analog data values and parameters. Maintain error thresholds externally to facilitate operator updates; additionally, the operator shall be able to adjust error thresholds during test runs.

b. Error messages shall indicate the out-of-tolerance data value and the expected or minimum/maximum condition.

5.1.3.1.8 Display Data From Functional Test. An instrument functional test (antenna placed in warm calibrate beam position) shall compute system noise parameters, Gain and NEΔT. These parameters, along with channel warm and cold temperatures, shall be displayed.

5.1.3.2 Output Commands To Sensor. These output commands shall toggle the state of various instrument components. There are no critical commands; i.e., commands that could damage the instrument in any situation.

a. The operator shall be able to initiate a command to change the antenna sequencing mode (if more than one command is applied simultaneously, the priority is the listed order) to operate at full scan mode or cycle to one of 3 select scan positions.

   1. Full Scan (see Figures 4 and 5)

   2. Warm Calibration (see Figures 6 and 7)

   3. Cold Calibration (see Figures 8 and 9)

   4. Nadir beam position (see Figures 10 and 11).

Table IX. Reportable Out-of-Tolerance Data Items

1. ANALOG VOLTAGES
(a) +15 VDC
(b) −15 VDC
(c) +5 VDC
(d) +3.5 VDC (Variable)
(e) +7.0 VDC (Variable)
(f) +5.0 VDC (Variable)
(g) +28.0 VDC (Regulated Voltage)
(h) +28.0 VDC (Pulse Load Voltage)
2. ANALOG CURRENTS
(a) +28.0 VDC
(b) +28.0 VDC
(c) Individual Motor Current
3. REFLECTOR POSITION
4. PRT TEMPERATURES
(a) All IF Amplifiers
(b) Detector/Video Amplifier Assembly
(c) DC/DC Converter
(d) Inflight Warm Load Temperatures
(e) Dielectric Resonance Oscillator (DRO) and PLLO Temperatures
5. MISCELLANEOUS DATA
(a) Module Power (On/Off)
(b) Channel Power (On/Off)
(c) Scanner 1 Power (On/Off)
(d) Scanner 2 Power (On/Off)
(e) Encoder 1 (On/Off)
(f) Encoder 2 (On/Off)
(g) Standby Operation
(h) Module Totally OFF
(I) Redundant PLLO (On/Off)
(j) Dwell at Warm Cal Position
(k) Dwell at Cold Cal Position
(l) Dwell at Scene Station 15
(m) Full Scan

b. The operator shall be able to initiate a command to:

1. Cold calibration position 1-4 select
2. No mode
3. Safe.

5.1.3.3 Output Commands To Azonix Temperature Control System. The STE software shall allow the operator to initialize Azonix controllers for STE program control.

5.1.3.4 Output Commands To CTE. The operator shall be able to specify target temperature ranges; STE software shall step through temperatures within the specified range for calibration test cycling.

5.1.3.5 Output Data To System Disk. The following data shall be output to system disk:

a. Sensor data

b. Operator specified file(s) from an archive tape

c. CTE data

d. Calibration correction factors, computed during CTE testing.

5.1.3.6 Output Data To Tape. Data acquired during calibration testing shall be archived to magnetic tape for later playback and re-processing through calibration algorithms.

5.1.3.7 Output To Line Printer. The following shall be output to the line printer:

a. Histograms of calibrate (count-to-temperature correlation) data

b. Temperature distribution graph

c. Selectable instrument and CTE data displayed on the CRT

d. Calibration test results.

5.2 Performance and Quality Engineering Requirements

The following describes performance, error handling, and quality engineering requirements for the STE software, organized by function.

5.2.1 Performance Requirements

5.2.1.1 Timing And Sizing Requirements

5.2.1.1.1 Timing Requirements

5.2.1.1.1.1 Engineering Data. The STE software shall acquire Engineering Data at a rate dependent on engineering data packet size (256 bytes), MIL-STD-1553 data transfer frame size (64 8-bit bytes), and MIL-STD-1553 data transfer rate (1 kbps).

a. Unit A1-Engineering data, consisting of 146 8-bit bytes shall be acquired at a rate less than (due to slower data transfer rate) but consistent with Low Rate Science timing.

b. Unit A2-Engineering data, consisting of 82 8-bit bytes shall be acquired at a rate less than (due to slower data transfer rate) but consistent with Low Rate Science timing.

5.2.1.1.1.2 Low Rate Science. The STE software shall acquire Low Rate Science data frames at a rate dependent on low rate science I/O data packet size (1024 bytes), MIL-STD-1553 data transfer frame size (64 8-bit bytes), and MIL-STD-1553 data transfer rate (100 kbps). Low Rate Science data availability coincides with data acquisition at each beam position. Beam position data, consisting of 30 beam positions per scan, shall be acquired at approximate 8 second intervals. Therefore, STE software shall submit data requests as needed (double required rate) to ensure date frame I/O at data acquisition. This shall ensure no data will be missed for updates and monitoring.

5.2.1.1.1.3 CTE. The STE software shall acquire current CTE data over an RS-232 serial data interface at least once per scan.

5.2.1.1.2 Sizing Requirements

5.2.1.1.2.1 Unit A1 Sizing Requirements. The sizing requirements are as follows:

a. The STE software shall reserve sufficient available memory to store two 146 byte (8-bit) buffers of engineering data.

b. The STE software shall reserve sufficient available memory to store two 1282 byte (8-bit) buffers of Low Rate Science scan data (see Low Rate Science timing requirements).

c. The STE software shall reserve sufficient available memory to store two 200 byte (8-bit) buffers of CTE data, acquired at least once per scan. Also, memory shall be sufficient to store an additional two 40 byte (16-bit) buffers of data, on a less frequent basis.

5.2.1.1.2.2 Unit A2 Sizing Requirements. The sizing requirements are as follows:

a. The STE software shall reserve sufficient available memory to store two 82 byte (8-bit) buffers of engineering data.

b. The STE software shall reserve sufficient available memory to store two 344 byte (8-bit) buffers of Low Rate Science scan data (see Low Rate Science timing requirements).

c. The STE software shall reserve sufficient available memory to store two 200 byte (8-bit) buffers of CTE data, acquired at least once per scan. Also, memory shall be sufficient to store an additional two 40-byte (16-bit) buffers of data, on a less frequent basis.

5.2.1.2 Sequence And Timing Of Events, Including Operator Interaction Tolerances

5.2.1.2.1 Sequence Of Events. The operator shall first select an instrument and then select options.

5.2.1.2.1.1 Select Instrument. The operator shall be able to select an instrument (unit A1 or A2) to test.

5.2.1.2.1.2 Select Options. The operator shall be able to display data to CRT monitor and output commands which change instrument modes and CTE thermal environment. The operator shall be able to display: 1) a selected data element from the three choices for continuous update and monitoring; 2) the current scan data block. The operator shall be able to output commands: 1) for CTE calibration performance testing to establish compliance with specification requirements for NEΔT, linearity, and absolute accuracy parameters; 2) to change the modes of various instrument components.

The operator shall be able to select options from the following nested menus.

Display data
- Display sensor data
  - Display a selected data element
    - Scan scene data
    - Telemetry command status
    - Component analog values
  - Display current scan data block
    - Scan scene data
      - Beam position (all channels)
      - Channel number (all beam positions)
      - Raw data stream
      - Calibrate data (all channels)
      - Reflector position
      - Temperature elements
    - Telemetry command status
    - Component analog values
      - Currents and Voltages
      - Unpowered PRTs
- Display CTE data
  - Display a selected data element
    - Scan scene data
    - Telemetry command status
    - Component analog values
  - Display CTE current scan data block
    - Scan scene data
      - PRT temperatures
      - Thermocouple temperatures

Output commands options
- CTE calibration performance testing
- Change digital telemetry data
  - Scanner power
  - Antenna position
  - Survival heater status
  - Cold calibration position

5.2.1.2.2 Timing Of Events

5.2.1.2.2.1 Timing Requirements For Display Data Options. The timing requirements shall be:

a. Display selected data elements for continuous update and monitoring when requested by the operator. Update these data elements at a rate correlated to data acquisition timing. Additional time for VAX I/O to data displays is expected.

b. Display current complete 8-second scan data blocks when requested by the operator. Updates to displayed scan data blocks shall be accomplished only for continuously monitored data elements.

5.2.1.2.2.2 Timing Requirements For Output Commands Options. See timing requirements above. Verification within 2 scans (16 sec).

5.2.1.3 Throughput And Capacity Requirements

5.2.1.3.1 Throughput Requirements

5.2.1.3.1.1 Engineering Data. Due to requirements for continuous monitoring of selected data elements, Engineering data elements shall be acquired and displayed before they are updated in the next 8 second readout.

5.2.1.3.1.2 Low Rate Science Data. Due to requirements for continuous monitoring of selected data elements, Low Rate Science data elements shall be acquired and displayed before they are updated in the next 8 second readout.

5.2.1.3.1.3 Calibration Test Equipment Data. CTE data is acquired once each scan. Therefore, due to requirements for continuous monitoring of selected data elements, CTE data elements shall be acquired and displayed before they are updated in the next scan.

5.2.1.3.2 Capacity Requirements. Since the STE environment employs virtual memory, this requirement is not applicable.

5.2.2 Error Handling

5.2.2.1 Error Detection And Isolation Requirements. Error detection and isolation shall be employed in the STE software monitor functions: data monitoring and calibration test monitoring.

5.2.2.1.1 Data Monitoring. Error message to the operator console CRT and system printer shall be output when:

a. Reflector position does not match operator command reflector position (this element is shown in Table IX).

b. Temperature (PRT) data is out-of-tolerance to test minimum/maximum limits (qualifying PRT temperature elements are shown in Table IX).

c. Analog data (current/voltages) are out-of-tolerance to test minimum/maximum limits (qualifying analog elements are shown in Table IX).

d. Unpowered PRT data is out-of-tolerance to test minimum/maximum limits (qualifying unpowered PRT elements are shown in Table IX).

e. Command not verified within 2 scans (16 sec).

5.2.2.1.2 Calibration Test Monitoring. When actual status modes do not match operator command test modes, modes shall be displayed (qualifying status elements are shown in Table IX).

Error message to the operator console CRT and system printer shall be output when:

a. PRTs, in the test targets and baseplates, indicate temperature changes, exceeding 0.1°C and 1.0°C, respectively.

b. PRTs, in the test targets, indicate temperature gradients across test targets exceeding 0.075°C.

c. PRTs, in the test targets and baseplates, indicate improper target temperatures for test mode selected (improper test setup).

Calibration test results for NEΔT and calibration accuracy shall be displayed. This shall enable operator examination of compliance with specification requirements.

5.2.2 Error Recovery Requirements

5.2.2.2.1 Reset Digital Telemetry Data. The operators shall be able to interactively reset sensor Engineering Data digital telemetry elements (instrument power and positioning). This shall enable operator control over antenna positioning and instrument/component power in the event of monitored errors or failures.

5.2.2.2.2 Reset Current/Voltage And PRT Limits. The operators shall be able to interactively reset critical sensor current/voltage elements and unpowered PRT limits criteria. This shall enable the operator to step through various CTE test scenarios uninterrupted, in the event that out-of-tolerance conditions are encountered.

5.2.3 QUALITY ENGINEERING

5.2.3.1 Reliability. The STE software shall maintain out-of-tolerance limits tables for those items in the Error Detection And Isolation Requirements section having minimum/maximum limits.

The STE software shall maintain out-of-tolerance limits tables to enable operator control of target temperatures during calibration testing.

The STE software shall evaluate instrument data for missing or erroneous values. The STE software shall provide data handling to recover from these conditions so as not to adversely impact software operation or instrument function.

The STE software shall establish STE Initialization or Start-Up procedures to assist operator interface to the test environment. The STE software shall inform operator if test setup is improper for type of test to be performed.

5.2.3.2 Maintainability And Portability. The "STE" software was specifically developed to test the EOS/AMSU-A instrument, for test engineers. The software is constrained to run on the "DEC" microvax system under "VMS". The software was developed with a modular structure using the fortran language to afford maintenance in the future.

5.3 SAFETY REQUIREMENTS

5.3.1 SAFETY HAZARDS. None.

5.3.2 OPERATOR CONSIDERATIONS. Critical tasks shall include: 1) Monitor critical instrument PRTs, Engineering data, and unpowered PRTs for operator specified out-of-limits conditions (see Error Detection And Isolation Requirements section); 2) Notify the operator of invalid data and associated minimum/maximum limits. Operator processing shall enable the operator to turn off instrument power when monitored critical elements exceed power-shutdown thresholds.

5.4 SECURITY AND PRIVACY REQUIREMENTS

The STE software shall conform to log-on access protocol, utilizing operator identification and password.

5.5 IMPLEMENTATION CONSTRAINTS

The following items, affecting STE interface to external input, are identified as constraints to STE software implementation.

a. RS-232 serial interface to CTE and power-off instrument PRTs (unpowered PRTs)

b. MIL-STD-1553 interface to the instrument

c. The STE software is constrained to run on the DEC MicroVAX.

5.6 SITE ADAPTATION

The STE software shall be used by test engineers at Aerojet to evaluate the performance of the Unit A1 and A2 instruments. Therefore, no STE site-specific adaptations are required.

5.7 DESIGN GOALS

The design goals (these are not testable requirements) shall include the following:

a. Reliably and accurately output operator requested Unit A1 and A2 data.

b. Create structured data displays in an operator friendly format. Supplement with clear, unambiguous instructions to permit operator interaction.

c. Maintain data displays which are current (both static or continuous updates).

d. Perform required instrument and CTE tests, including algorithm sequences, correctly and precisely.

e. Generate error messages which clearly describe error and condition violated during STE operation.

Section 6

TRACEABILITY TO PARENT'S DESIGN

All EOS/AMSU-A STE software design documents are traceable to this requirements specification. The requirements were derived from six documents: GIRD, etc. The allocation of the requirements to the software requirements are shown in Table X.

Table X Special Test Equipment Software Requirements Traceability Matrix

System Requirement	Description	SRS	Module	Test
9.2.2(2) [P]	Command sending and verification	5.1.3.2 [2]	(STE) A1_3780_COMMAND _PROCESS	4.6 [4]
9.2.2(2) [P]	Analyze data from AMSU-A	5.1.2.2 [2]	(STE) A1_ 5XX	4.9[4]
9.2.2(3) [P]	"Real-time" data analysis	5.1.3.1 [2]	(STE) A1_ 36XX	4.5 [4]
9.2.2(3) [P]	Print out results	5.1.3.7 [2]	(STE) A1_ 9700 _PRINT_ SCREEN	4.9 [4]
9.2.2(3) [P]	Continuous magnetic tape recording	5.1.3.5 [2] 5.1.3.6	(STE) A1_3400_READ_8_SEC_BLOCK	4.7[4]
9.2.2(4) [P]	Decommutate any word or channel test set and display with ID	5.1.3.1 [2]	(STE) A1_36XX	4.3, 4.4 [4]
9.2.2(5) [P]	I/F with blackbody targets	[2]	(STE) A1_94XX, A1 _5XXX	4.9
9.2.2(6) [P]	Test voltages and signals	[2]	(STE) A1_2600_LIMIT_ CHECK	4.5
9.2.2(8) [P]	Include self-test	[2]	(STE) A1_8000_SELF _TEST	TBD
Derived	Process and data requirements	5.1 [2]	(STE) N/A	N/A
Derived	Input data and sources	5.1.1 [2]	(STE) N/A	N/A
Derived	Sensor data	5.1.1.1 [2]	(STE) N/A	N/A
Derived	Unit data structure	5.1.1.1.1 [2]	(STE) N/A	N/A
Derived	Low rate science data	5.1.1.1.1.1 [2]	(STE) A1_36XX, A1_37XX	4.4 [4]
Derived	Engineering data	5.1.1.1.1.2 [2]	(STE) A1_36XX,A1 _37XX	4.3 [4]
Derived	Unpower PRTs	5.1.1.1.1.3 [2]	(STE) A1_3730_ANALOG_PARSE	4.1 [4]
Derived	Calibration test equipment	5.1.1.2 [2]	(STE) N/A	N/A
Derived	Unit data strumction	5.1.1.2.1 [2]	(STE) N/A	NA
Derived	CTE PRT & thermocouple data	5.1.1.2.1.1 [2]	(STE) A1_36XX	4.9.4 [4]
Derived	Transactions/algorithms	5.1.2 [2]	(STE) N/A	N/A
Derived	Sensor transactions	5.1.2.1 [2]	(STE) A1_3730_ANALOG_PARSE, A1_3670_THERM_DATA	4.9.3, 4.9.4 [4]
Derived	CTE transactions	5.1.2.2 [2]	(STE) A1_5XXX	4.9.3, 4.9.4 [4]
Derived	Output data and destination	5.1.3 [2]	(STE) N/A	N/A
Derived	Display data on video terminal	5.1.3.1 [2]	(STE) N/A	N/A
Derived	Display science data	5.1.3.1.1 [2]	(STE) A1_36XX, A1_37XX	4.4 [4]
Derived	Display engineering data	5.1.3.1.2 [2]	(STE) A1_36XX, A1_37XX	4.3 [4]
Derived	Display CTE data	5.1.3.1.3 [2]	(STE) A1_36XX	4.9.4.1 [4]
Derived	Display unpowered PRTs	5.1.3.1.4 [2]	(STE) A1_3730_ANALOG_PARSE	4.1.1 [4]
Derived	Display data stored on disk	5.1.3.1.5 [2]	(STE) A1_4100_DATA_COLLECTION_INIT	4.7 [4]
Derived	Display data stored on mag tape	5.1.3.1.6 [2]	(STE) A1_6XXXX	4.7 [4]
Derived	Display data errors	5.1.3.1.7 [2]	(STE) A1_2500_ERROR_MESSAGE_DISPLAY	4.5 [4]
Derived	Display data from functional test	5.1.3.1.8 [2]	(STE) A1_4700_FUNCTIONAL TEST	——
Derived	Output commands to sensor	5.1.3.2 [2]	(STE) A1_3780_COMMAND PROCESS	4.6 [4]
Derived	Output commands to AZONIX	5.1.3.3 [2]	(STE) A1_4100_DATA_COLLECTION_INIT	4.9.3.1 [4]
Derived	Output commands to CTE	5.1.3.4 [2]	(STE) A1_4100_DATA_COLLECTION_INIT	4.9.3.1 [4]
Derived	Output data to system disk	5.1.3.5 [2]	(STE) A1_3400_READ_8_SEC_BLOCK	4.7 [4]

G – Gird, P – POS, 1–RPT 10458 (CDRL 306-2B), 2 – RPT10457 (CDRL 306-2A), 3 – AE26600 (CDRL 415), 4 – AE26602 (CDRL 415)

Table X Special Test Equipment Software Requirements Traceability Matrix

System Requirement	Description	SRS	Module	Test
Derived	Output data to tape	5.1.3.6 [2]	(STE) A1_2000_MAIN_MENU	4.7 [4]
Derived	Output to line printer	5.1.3.7 [2]	(STE) A1_97XX	4.9 [4]
Derived	Performance and quality engineering	5.2 [2]	(STE) N/A	N/A
Derived	Performance requirements	5.2.1 [2]	(STE) N/A	N/A
Derived	Timing and sizing	5.2.1.1 [2]	(STE) N/A	N/A
Derived	Timing	5.2.1.1.1 [2]	(STE) N/A	N/A
Derived	Engineering data	5.2.1.1.1.1 [2]	(STE) A1_36XX,A1_37XX	4.3 [4]
Derived	Low rate science data	5.2.1.1.1.2 [2]	(STE) A1_36XX,A1_37XX	4.4 [4]
Derived	CTE	5.2.1.1.1.3 [2]	(STE) A1_36XX	4.9 [4]
Derived	Sizing	5.2.1.1.2 [2]	(STE) N/A	N/A
Derived	Unit A1 sizing	5.2.1.1.2.1 [2]	(STE) N/A	N/A
Derived	Unit A2 sizing	5.2.1.1.2.2 [2]	(STE) N/A	N/A
Derived	Sequence and timing of events	5.2.1.2 [2]	(STE) N/A	N/A
Derived	Sequence of events	5.2.1.2.1 [2]	(STE) N/A	N/A
Derived	Select instrument	5.2.1.2.1.1 [2]	(STE) A1_2000_MAIN MENU	4.1 [4]
Derived	Select options	5.2.1.2.1.2 [2]	(STE) A1_3600_NORM_MON_USER_INPUT	4.3, 4.4 [4]
Derived	Timing of events	5.2.1.2.2 [2]	(STE) N/A	N/A
Derived	Timing for display	5.2.1.2.2.1 [2]	(STE) A1_36XX,A1_37XX	4.3, 4.4 [4]
Derived	Timing for output	5.2.1.2.2.2 [2]	(STE) A1_3780_COMMAND_PROCESS	4.6 [4]
Derived	Throughput and capacity	5.2.1.3 [2]	(STE) N/A	N/A
Derived	Throughput	5.2.1.3.1 [2]	(STE) N/A	N/A
Derived	Engineering data	5.2.1.3.1.1 [2]	(STE) A1_36XX, A1_37XX	4.3 [4]
Derived	Low rate science data	5.2.1.3.1.2 [2]	(STE) A1_36XX, A1_37XX	4.4 [4]
Derived	Calibration test equipment data	5.2.1.3.1.3 [2]	(STE) A1_36XX	4.9 [4]
Derived	Capacity	5.2.1.3.2 [2]	(STE) N/A	N/A
Derived	Error handling	5.2.2 [2]	(STE) N/A	N/A
Derived	Error detection and isolation	5.2.2.1 [2]	(STE) N/A	N/A
Derived	Data monitoring	5.2.2.1.1 [2]	(STE) A1_2500_ERROR_MESSAGE_DISPLAY	4.5 [4]
Derived	Calibration test monitoring	5.2.2.1.2 [2]	(STE) A1_2500_ERROR_MESSAGE_DISPLAY	4.5 [4]
Derived	Error recovery	5.2.2.2 [2]	(STE) N/A	N/A
Derived	Read digital telemetry	5.2.2.2.1 [2]	(STE) A1_3780_COMMAND_PROCESS	4.5 [4]
Derived	Read current/voltage limits	5.2.2.2.2 [2]	(STE) A1_2800_SET_LIMITS	4.5 [4]
Derived	Quality engineering	5.2.3 [2]	(STE) N/A	N/A
Derived	Reliability	5.2.3.1 [2]	(STE) A1_2XXX	4.5 [4]
Derived	Maintainability and portability	5.2.3.2 [2]	(STE) N/A	N/A
Derived	Safety	5.3 [2]	(STE) N/A	N/A
Derived	Safety hazards	5.3.1 [2]	(STE) N/A	N/A
Derived	Operator considerations	5.3.2 [2]	(STE) A1_2XXX,A1_36XX,A1_37XX	4.5 [4]
Derived	Security and privacy	5.4 [2]	(STE) N/A	4.1 [4]
Derived	Implementation constraints	5.5 [2]	(STE) N/A	N/A
Derived	Site adaptation	5.6 [2]	(STE) N/A	N/A
Derived	Design goals	5.7 [2]	(STE) N/A	N/A

G – Gird, P – POS, 1–RPT 10458 (CDRL 306-2B), 2 – RPT10457 (CDRL 306-2A), 3 – AE26600 (CDRL 415), 4 – AE26602 (CDRL 415)

Section 7

PARTITIONING FOR PHASED DELIVERY

Not applicable. STE software shall be delivered as a single package.

Section 8

ABBREVIATIONS AND ACRONYMS

A1	EOS/AMSU-A1 (Unit A1)
A2	EOS/AMSU-A2 (Unit A2)
AMSU	Advanced Microwave Sounding Unit
BP	Beam Position
Cal	Calibration
CDR	Critical Design Review
Ch	Channel
CTE	Calibration Test Equipment
CRT	Cathode Ray Tube
DEC	Digital Equipment Corporation
Delta G	Gain drift as a function of time
DRO	Dielectric Resonance Oscillator
EOS	Earth Observing Satellite
FFT	Fast Fourier Transform
FSP	Frame Sync Pulse
G	Gain
Hex	Hexadecimal
Hz	Hertz (frequency)
ID	Identification
I/O	Input/Output
K	Kelvin
kbps	Kilo Bits-Per-Second
MTU	Magnetic Tape Unit
N/A	Not Applicable
NEΔT	Noise Equivalent Delta Temperature
PLLO	Phased Lock Loop Oscillator (primary or redundant)
PRT	Platinum Resistance Thermometer
RF	Radio Frequency
RS-232	Serial Interface
STE	Special Test Equipment
TMCS	Temperature Measurement and Control System (Azonix)
VDC	Volt Direct Current
VMS	Digital Operating System

Section 9

GLOSSARY

AMSU-A	Generic reference to previous AMSU units A1 and A2
EOS/AMSU-A	Generic reference to EOS AMSU-A units A1 and A2
MIL-STD-1553	STE interface to instrument firmware

Section 10

NOTES

None.

Section 11

APPENDICES

None.

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Report Documentation Page

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